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MAMMALIAN FAUNA OF THE MIOMBO FOREST IN THE UGALLA AREA, WESTERN TANZANIA

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ABSTRACT We collected basic data on the mammalian fauna of the Ugalla area (05°13.0'S, 30°27.5'E), western Tanzania. We identified 50 mammalian species: seven species of Primates; at least one unidentified species of Chiroptera; two identified species of Lagomorpha; four identified species of Rodentia; 17 identified and at least two unidentified species of Carnivora; one species of Tubulidentata; one species of Hyracoidea; and 15 species of Artiodactyla. Nineteen of these species had not previously been reported from Ugalla. Moreover, eight of these mammal species had not previously been confirmed in this area, according to the Red List of the International World Conservation Union. Ugalla has a diverse mammalian fauna, including species that originated in the tropical rainforest and acacia savanna. In addition, our surveys suggest that genets, African civets, leopards, bush hyraxes and southern reedbucks have different ecologies from mammals in other regions.

Key Words: Mammalian fauna; Miombo forest; Ugalla; Diversity.

INTRODUCTION

The miombo forest in western Tanzania is located in a region in which the main vegetation changes from tropical rainforest to acacia savanna. Various plants and animals in the miombo forest originate from both the tropical rainforest and the savanna (Kano, 1971; Moore, 1994). In recent years, however, miombo forests in eastern Africa have been reduced by human activities such as slash-and-burn farming and deforestation (Abbot & Homewood, 1999). For example, small settlements of the Tongwe people were scattered in the Ugalla area of western Tanzania before the 1960s (Itani, 1979; Ogawa et al., 1999). This area became uninhabited when the Ujama policy was introduced in 1967. At present, however, roads have been extended and a mega-dam is being constructed in and around the area. These activities have damaged the ecosystem of this area. The number of medium- and large-sized mammals has already been reduced in the Ugalla area by human activities such as felling trees for commercial timber (Ogawa et al., 1999).

Because the Ugalla area is the eastern limit of the distribution of chimpanzees (*Pan troglodytes*) in the African continent, a large number of primatological and anthropological studies have been performed in the region since the 1960s (Hernandez-Aguilar, 2006; Idani, 2002; Itani, 1979; Kano, 1971; 1972; Moore,

1994; Nishida, 1989; Ogawa et al., 1999; 2007). However, fewer ecological and behavioral studies of mammals other than chimpanzees have been conducted in this area. A list of medium and large mammals found in the Ugalla area was compiled. In addition, lists of primates, rodents and insectivores found in the Ugalla area were made (Hernandez-Aguilar, 2006; Ogawa et al., 1999; 2007). However, these lists are not complete and does not include small mammals, except rodents and insectivores. Moreover, the species that inhabit the area may have changed since 2007. In this study, we conducted a survey of the mammalian fauna and the environments inhabited by mammals in the Ugalla area.

METHODS

I. Study Area

The Ugalla area covers 3,352 km^2 and is located about 100 km inland from Lake Tanganyika. The area is bounded by the Malagarasi River to the north, the Niamansi Basin to the south, the Ugalla River to the east, and the Uvinza-Mpanda Road to the west (Fig. 1). The Malagarasi River is the largest river flowing into Lake Tanganyika and runs from east to west at the north end of the study area. Field surveys were conducted mainly at the Nguye site in the northwest Ugalla area (05°13.0'S, 30°27.5'E; Fig. 1).

The climate in the Ugalla area is characterized by a long dry season. The year is divided into the rainy season between November and April and the dry season between May and October. This long dry season and the geographical and geological features of the area cause most streams in the Ugalla area to dry up by the end of the dry season.(1)

According to vegetation map of Africa, the Ugalla area is classified as deciduous woodland (Mayaux et al., 2004). In contrast, various generic terms such as "miombo forest," "miombo woodland," and "savanna woodland" have been used in previous studies to refer to the whole of the vegetation of the Ugalla area (Idani, 2002; Itani, 1979; Kano, 1971; 1972; Moore, 1994; Nishida, 1989; Ogawa et al., 1999; 2007). Because there are no standard rules for vegetation term use, we herein use "miombo forest" as a generic term to refer to the vegetation of the area.

The miombo forest of the Ugalla area includes three main vegetation types (Fig. 2): (1) woodland, (2) evergreen forest, and (3) grassland (Idani, 2002; Ogawa et al., 1999; 2007). Most of the Ugalla area is composed of woodlands dominated by deciduous trees of *Brachystegia* spp. and *Julbernardia* spp. that are locally referred to as miombo woodlands (Itani, 1979; Kano, 1971; 1972; Moore, 1994; Nishida, 1989).

Woodland occupies more than 80% of the total area in Ugalla, whereas evergreen forest covers 9.8% of the area, and no more than 8.5% is grassland (Idani, 2002). The evergreen forest can be subdivided into kabamba-jike (*Monopetalanthus richadsiae*) forest, valley forest, and flat riverine forest (Idani, 2002; Ogawa et al., 1999). The Ugalla area has rocky terrain, and rocky outcrops form craggy

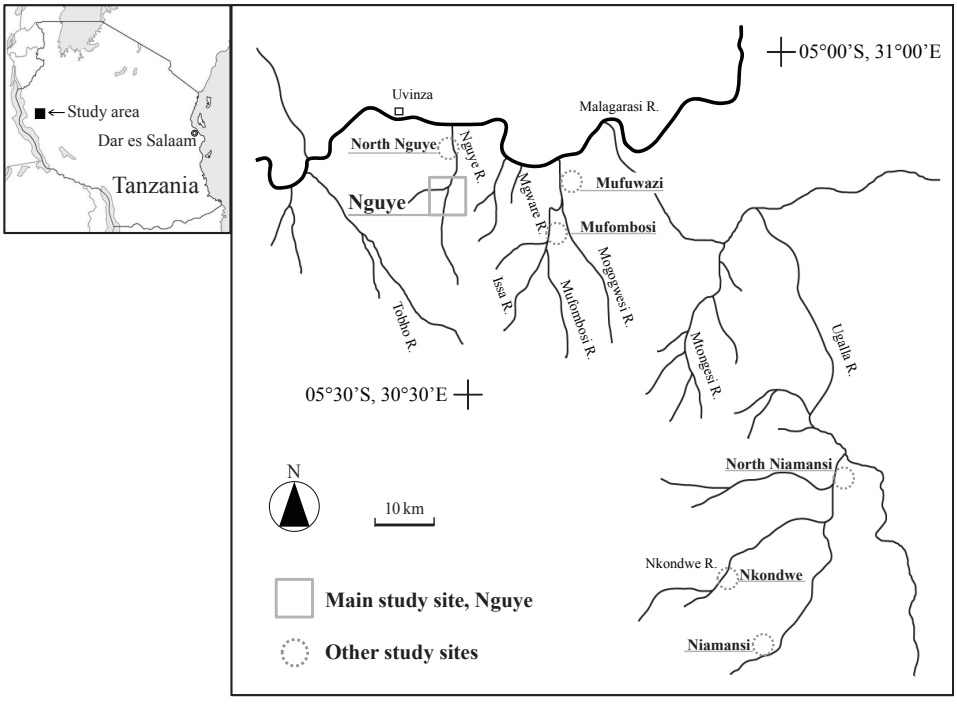

Fig. 1. Ugalla study site.

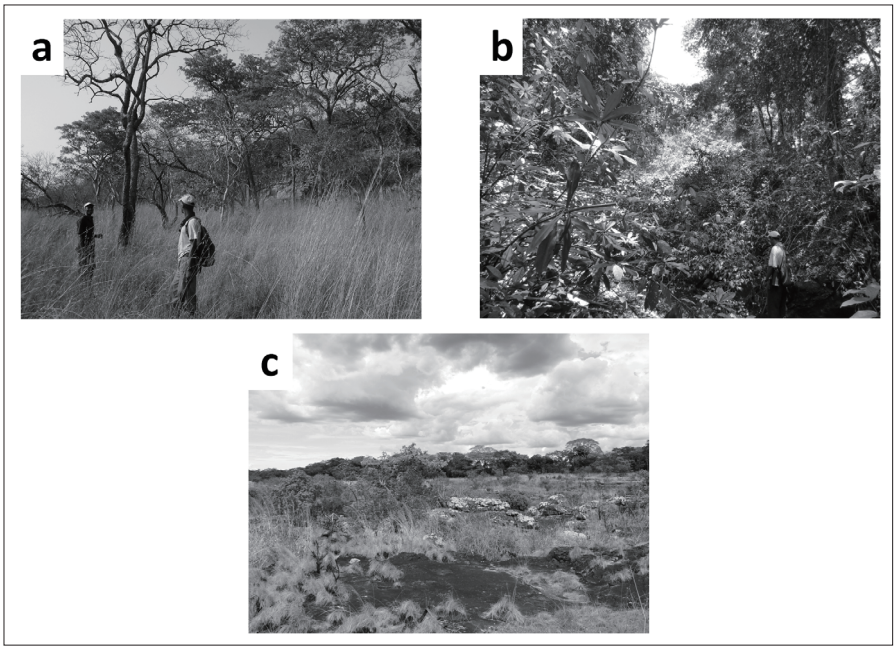

Fig. 2. Vegetation types of the Ugalla area. a) woodland, b) evergreen forest, and c) grassland.

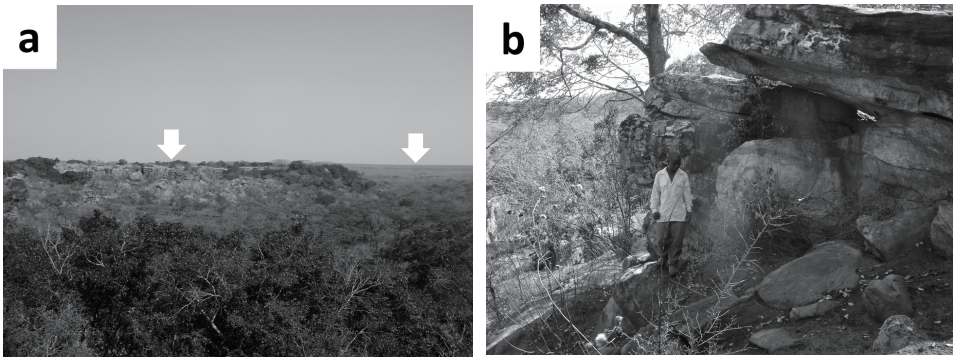

Fig. 3. Rocky sites in the Ugalla area. a) Rocky outcrops form craggy places along the contour lines. The arrows show lines of rocky outcrops. b) Rocky sites in woodland areas.

places along the contour lines in the woodlands, evergreen forests, and grasslands (Fig. 3). It must be emphasized that the data presented here come from a small fraction of the area, and a "full description" of Ugalla is not yet available. However, the Nguye site includes all the vegetation and geographical features and is characteristic of the Ugalla area.

II. Study Methods

E.G. Iida conducted surveys at the Nguye site (05°13.0'S, 30°27.5'E) on Sept. 1–2, 2009; Jun. 23–Aug. 15, 2010; and Aug. 26–Dec. 11, 2011. H. Ogawa conducted surveys at Nguye on Aug. 10–31, 2007; Feb. 25–March 3, 2010; Aug. 8–Sept. 1, 2010; and Aug. 1–31, 2011. H. Ogawa also conducted surveys at Nguye and the other sites (north Nguye, Mufuwazi, Mufombosi, north Niamansi, and Nkondwe) between Aug. 2–9, 2008.

(1) We performed a random walking census of about 50 km^2 in the Nguye site with local guides and recorded mammal species by direct observation and from field signs of animals (droppings, footprints, hairs, scars, and prey remains). We also recorded the environment where the animals were observed or where the field signs were found. H. Ogawa used the same methodology to collect data to fill in the gaps in the observation of mammalian fauna. However, we did not include those mammals observed only at other study sites in the list. In addition, we did not include the data from observations by only the local guides.

(2) We placed camera traps (sensor cameras) in and around rocky sites to obtain photographs of animals that passed along animal trails. We put camera traps (Bushnell 119455C Trophy Night Vision Trail Camera) at eight sites for 730 camera days from Aug. 31 to Dec. 7, 2011. We used only data for animals that could be specifically identified.

We collected additional information from villagers who visit Nguye. The local names for the animals were recorded in Ki-Ha, the local language of Ha people in the area, and Ki-Swahili, the official language of Tanzania. Because animal names differ among regions, we used an animal picture book to clarify any ambiguous animal names (Mdee & Kiango, 2008).

RESULTS

We recorded a total of 50 mammalian species in the Ugalla area between 2007 and 2011 (Table 1). There were: seven species of Primates; at least one unidentified species of Chiroptera; two identified species of Lagomorpha; four identified species of Rodentia; 17 identified and at least two unidentified species of Carnivora; one species of Tubulidentata; one species of Hyracoidea; and 15 species of Artiodactyla. The only rodents listed in Table 1 are porcupines, squirrels, and rats because identification of other rodents is ongoing. We categorized mammals in the Ugalla area according to the original distribution of each species (Stuart & Stuart, 2007): 17 savanna, six woodland, and three tropical rainforest. We observed 38 (76.0%) of the 50 mammals at rocky sites (Table 1).

I. Carnivora

We observed a pair of side-striped jackals (*Canis adustus*) during the day at a rocky site in a woodland area on Aug. 13, 2010. We also found footprints of a mother and her offspring on Nov. 2, 2011. Camera traps photographed a jackal scavenging remains of a baboon that appeared to have been hidden by a leopard on Sep. 28, 2011, judging from tooth and claw marks.

African civets (*Civettictis civetta*) were found at rocky sites in woodland areas. An African civet visited our camp every night during the dry season and scavenged the remains of our meals. Residues of their feces contained mixtures of soaps, plastics, and honeycombs.

The miombo genet (*Genetta angolensis*), common genet (*Genetta genetta*), and central African large-spotted genet (*Genetta maculata*) were found only at rocky sites. We observed animals that appeared to be hybrids of the miombo genet and central African large-spotted genet. Camera traps also photographed possible hybrids four times. These genets had coat spots with the same pattern as central African large-spotted genets, but the inside of the upper hind leg, the forefoot, and the upper arm had a dark coat, as observed only in miombo genets (Fig. 4). We found the carcass of a female possible hybrid that had just been killed by a leopard (*Panthera pardus*) on Sep. 22, 2011. On Sep. 24, 2011, two days after the discovery, a camera trap took pictures of another genet that approached to sniff the carcass.

Servals (*Leptailurus serval*) inhabited both evergreen forests and woodlands. Footprints indicated that a serval had attacked a helmeted guinea fowl (*Numida meleagris*) on Dec. 7, 2011. Our research assistant, Hamisi Stiven, observed that a serval was resting in a rock crevice in the daytime on Sep. 18, 2011.

A male honey badger (*Mellivora capensis*) caught a bush hyrax (*Heterohyrax brucei*) and kept it in rock crevice (53 cm in length, 230 cm in width, and 390 cm in depth). The ratel spent the entire day in the crevice.

We found the body remains of two klipspringers (*Oreotragus oreotragus*) and one common duiker (*Sylvicapra grimmia*) that had been hidden by leopards in rock crevices, as determined from tooth and claw mark feeding signs. Fecal analyses showed that leopards ate porcupines (*Hystrix* spp.), bush hyraxes, klipspringers,

Table 1. Mammals in the Ugalla area in 2007–2011

Common name	Latin name	IUCN base		Record		Evidence			
		Red list	Distributional area	1	2	Direct observation	Camera trap	Other	Rocky stretch
CARNIVORA									
African clawless otter	*Aonyx capensis*	LC	s,w,t		*	*			
Marsh mongoose	*Atilax paludinosus*	LC	s,w,t		*			*	*
Bushy-tailed mongoose	*Bdeogale crassicauda*	LC	w	*	*		*	*	*
Side-striped jackal	*Canis adustus*	LC	w			*	*		*
Black-backed jackal	*Canis mesomelas*	LC	s,w,t			*			
African civet	*Civettictis civetta*	LC	s,w,t				*	*	*
Miombo genet	*Genetta angolensis*	LC	w	*	*	*	*		*
Common genet	*Genetta genetta*	LC	s,w,t		*		*		*
Central African large-spotted genet	*Genetta maculata*	LC	s,w,t		*		*		*
Common dwarf mongoose	*Helogale parvula*	LC	s		*	*	*	*	*
Slender mongoose	*Herpestes sanguineus*	LC	s		*		*		*
Serval	*Leptailurus serval*	LC	s		*			*	*
African wild dog	*Lycaon pictus*	EN	s			*		*	
Honey badger	*Mellivora capensis*	LC	s,w,t				*	*	*
Banded mongoose	*Mungos mungo*	LC	s		*	*	*		*
Lion	*Panthera leo*	VU	s					*	
Leopard	*Panthera pardus*	NT	s,w,t			*	*	*	*
Hyena	*unidentified*	?	–					*	
Fox	*unidentified*	?	–	*		*			*
PRIMATES									
Red-tailed monkey	*Cercopithecus ascanius*	LC	t			*	*	*	*
Blue monkey	*Cercopithecus mitis*	LC	–			*	*	*	*
Northern lesser galago	*Galago senegalensis*	LC	w,t			*		*	*
Thick-tailed greater galago	*Otolemur crassicaudatus*	LC	w			*		*	*
Chimpanzee	*Pan troglodytes*	EN	s,w,t			*	*	*	*
Olive baboon	*Papio anubis*	LC	s	*		*			*
Yellow baboon	*Papio cynocephalus*	LC	w			*	*	*	*
ARTIODACTYLA									
Impala	*Aepyceros melampus*	LC	s		*	*		*	
Lichtenstein's hartebeest	*Alcelaphus buselaphus ssp. Lichtensteinii*	LC	s	*		*		*	

Roan antelope	*Hippotragus equinus*	LC	s			*	*	*	*
Waterbuck	*Kobus ellipsiprymnus*	LC	s			*			
Klipspringer	*Oreotragus oreotragus*	LC	s,w			*	*	*	*
Common warthog	*Phacochoerus africanus*	LC	s			*	*	*	*
Blue duiker	*Philantomba monticola*	LC	t		*	*	*	*	*
Bushpig	*Potamochoerus larvatus*	LC	w,t			*	*	*	*
Southern reedbuck	*Redunca arundinum*	LC	w		*	*		*	*
Common duiker	*Sylvicapra grimmia*	LC	s			*	*	*	*
African buffalo	*Syncerus caffer*	LC	s,w,t					*	
Common eland	*Tragelaphus oryx*	LC	s,w					*	
Bushbuck	*Tragelaphus scriptus*	LC	w,t			*	*	*	*
Sitatunga	*Tragelaphus spekii*	LC	t			*		*	
Greater kudu	*Tragelaphus strepsiceros*	LC	s		*	*		*	
HYRACOIDEA									
Bush hyrax	*Heterohyrax brucei*	LC	s,w		*	*	*	*	*
TUBULIDENTATA									
Aardvark	*Orycteropus afer*	LC	s					*	*
CHIROPTERA									
Bat	*unidentified*	?	–			*			*
LAGOMORPHA									
African savanna hare	*Lepus microtis*	LC	–		*	*	*	*	*
Smith's red rock hare	*Pronolagus rupestris*	LC	s,w	*	*		*	*	*
RODENTIA									
Northern giant pouched rat	*Cricetomys gambianus*	LC	–	*		*	*		*
Cape porcupine	*Hystrix africaeaustralis*	LC	s				*	*	*
Crested porcupine	*Hystrix cristata*	LC	s	*	*		*	*	*
Smith's bush squirrel	*Paraxerus cepapi*	LC	–		*	*	*		*

*Red list: Red list category; EN, Endangered; VU, Vulnerable; NT, Near threatened; LC, Least concern; ?, unclear.
*Distributional area: The current condition of the distributional area in Africa (Stuart & Stuart, 2007); s, savanna (grassland, scrub); w, woodland (bush); t, tropical rainforest; –, unclear.
*Record: 1, Not confirmed in the Ugalla area in the IUCN Red List 2008; 2, First record in the Ugalla area (Hernandez-Aguilar, 2006; Ogawa et al., 1999; 2007).
*Evidence: Direct observation, directly observed; Camera trap, a photo taken by a camera trap; Other, vocalization and field signs (feces, hair, prey, bone, footprints, etc.).
*Rocky stretch: Observed at a rocky stretch.

Fig. 4. A possible hybrid between miombo genet and central African large-spotted genet.

common duikers, yellow baboons (*Papio cynocephalus*), and genets (*Genetta* spp.). Footprints of adult and juvenile leopards were found in a small cave on Nov. 11, 2011. On the same day, we found the footprints of adults in two places around the other rocks. One location was about 280 m north and the other was about 130 m west of the small cave. We found the shell of a giant African land snail (*Achatina* spp.) that appeared to have been killed by a mammal with large fangs.

From our camp, we heard the roars of lions (*Panthera leo*) 43 times in the distance between approximately 21:00 and dawn on Nov. 12, 2011. We found the skull and skeleton of a greater kudu (*Tragelaphus strepsiceros*) that lions had hunted on a woodland slope on Sep. 7, 2011. From the hair and footprints, we surmised that two lions had killed the kudu. In addition, hyena footprints and droppings were observed, although we could not identify the species or number of hyenas. Our research assistants observed a lion in 2011.

We observed African clawless otters (*Aonyx capensis*) in the evergreen forests. We found footprints of the marsh mongoose (*Atilax paludinosus*) in the woodlands. Slender mongoose (*Herpestes sanguineus*) and bushy-tailed mongoose (*Bdeogale crassicauda*) were found at rocky sites in the woodlands.

II. Primates

The blue monkey (*Cercopithecus mitis*) and the red-tailed monkey (*Cercopithecus ascanius*) have been observed previously only in evergreen forests. In this study, however, we observed two groups of blue monkeys, and a solitary blue monkey was photographed in the woodlands. We also observed a solitary red-tailed monkey at a rocky site in the woodlands.

Chimpanzees (*Pan troglodytes*) stayed for two nights in the same place in an evergreen forest (valley forest) on Oct. 10 and 12, 2011 (Fig. 5). There were eight beds one night and 10 beds on the other. A male performed displays on

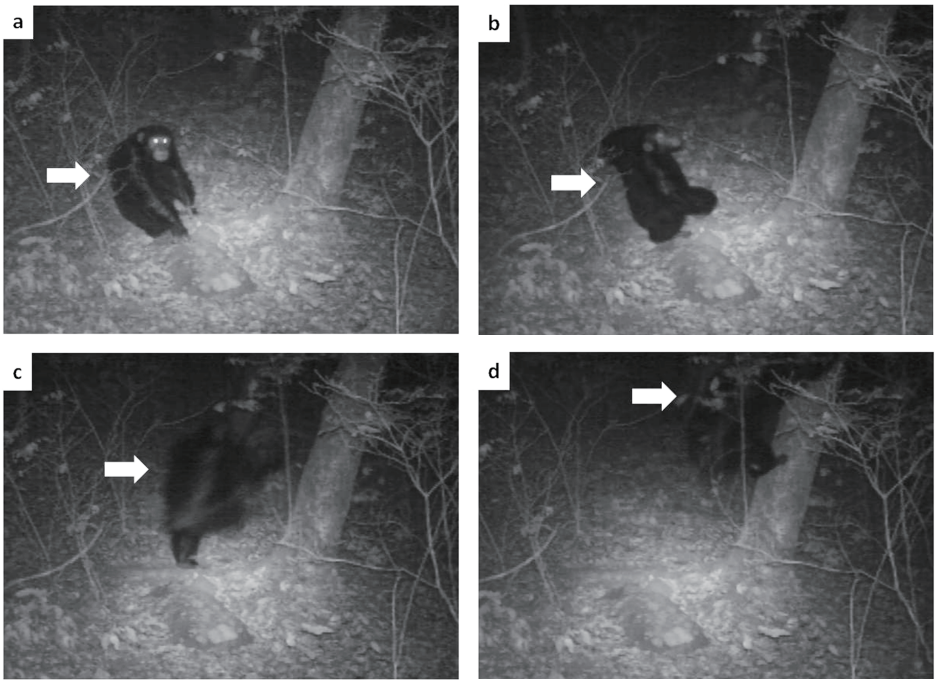

Fig. 5. Nighttime behaviors of a male chimpanzee (03:45–03:46 on Oct. 10, 2011).

a) Sitting on a rock in the rain and frequently looking up into a tree in front of him.
b) Standing up with his hair standing on end.
c) Jumping into a tree.
d) Climbing up the tree.

the ground at midnight. After that, at least two males sat, walked on the ground, and climbed up and down trees repeatedly in the rain. On the same day, we observed eight chimpanzees in the vicinity.

We observed a mixed group of the olive baboon (*Papio anubis*) and the yellow baboon. Some individuals had grey fur and might have been hybrids. The troop was composed of >20 individuals.

III. Ungulates

We observed three herds of the southern reedbuck (*Redunca arundinum*) during the rainy season. The herds were composed of four, five, and six heads, respectively. Footprints indicated that the largest herd in the area consisted of 12 individuals on Oct. 23, 2011. Because all the footprints appeared to be the same size, we were unable to attribute the signs to adults or juveniles with any certainty.

We observed impala (*Aepyceros melampus*) in woodlands and sitatunga (*Tragelaphus spekii*), African clawless otter (*Aonyx capensis*), and an unidentified bat in the evergreen forests. We found footprints and feces of the African buffalo (*Syncerus caffer*) in the evergreen forest, footprints of the common

eland (*Tragelaphus oryx*) in the evergreen forest, and footprints of the marsh mongoose (*Atilax paludinosus*) in woodlands.

We observed bush hyraxes in groups of 2–16 individuals and alone. They used crevices in the rock and termite mounds in the crags as burrows. These burrows were jointly used by sympatric species (Table 2). Bush hyraxes shared burrows with common dwarf mongooses (*Helogale parvula*), Smith's bush squirrels (*Paraxerus cepapi*), and northern giant pouched rats (*Cricetomys gambianus*).

Traces of old aardvark (*Orycteropus afer*) burrows were observed frequently, but we found signs of recent feeding at only two rocky sites in woodlands and evergreen forests. On one occasion we found evidence that poachers had dug into an aardvark burrow to catch the animal.

We could not find any traces of the African elephant (*Loxodonta africana*), plains zebra (*Equus quagga*), giraffe (*Giraffa camelopardalis*), lesser kudu (*Tragelaphus imberbis*), oribi (*Ourebia ourebi*), or sable antelope (*Hippotragus niger*) at Nguye sites after 2007.

IV. Others

A Smith's red rock hare (*Pronolagus rupestris*) was photographed only once at a rocky site in the woodland. The individual used the burrow of a mongoose during the night. We did not find any Smith's red rock hare latrine sites in the evergreen forest, but we did find some in the grasslands.

One male–female crested porcupine (*Hystrix cristata*) pair was found at a rocky site in a woodland and another pair was found in an evergreen forest. They burrowed in the ground under large rock outcrops. Cape porcupines (*Hystrix africaeaustralis*) were found during the night around rocky sites in woodlands

Table 2. Mammals that shared a burrow with the bush hyrax

Common name	Evidence		
	A	B	C
Leopard		*	*
Serval			*
Ratel		*	*
Common dwarf mongoose	*	*	*
Banded mongoose	*		
Slender mongoose	*	*	
Bushy-tailed mongoose		*	*
Smith's red rock hare		*	
African savanna hare	*		
Smith's bush squirrel	*		
Crested porcupine		*	*
Cape porcupine		*	*
Giant pouched rat	*		
Klipspringer			*

Evidence: A = Direct observation, B = Camera trap, C = Field signs (feces, hair, prey, bone, footprint, etc.).

and evergreen forests. These porcupines also burrowed in the ground under large rock outcrops. We captured a picture of a pair mating during the night. In their burrow, we found the femur of a buffalo or eland that had been gnawed by the porcupines.

V. Mammals at the Other Study Sites

The Grivet monkey (*Chlorocebus aethiops*) was found only in Nkondwe. African elephant (*Loxodonta africana*) were found only in Mufuwazi. Hippopotamus (*Hippopotamus amphibius*) was found only in north Nguye.

DISCUSSION

I. Mammalian Fauna in Ugalla

This study provides the first record of 19 species of mammals in the Ugalla area (Hernandez-Aguilar, 2006; Ogawa et al., 1999; 2007). Moreover, we recorded at least eight species of mammals that were not included in the Red List of the International Union for Conservation of Nature (IUCN) for the Ugalla area (Gaubert et al., 2008; Grubb et al., 2008; Hoffmann, 2008; IUCN SSC Antelope Specialist Group, 2008; Kingdon, 2008; Kingdon et al., 2008; Smith & Boyer, 2008, van der Straeten et al., 2008). Only three species of mammals were found at other study sites. It seems that the mammalian fauna at the other study sites was not much different from that at the Nguye site.

Various species from tropical rainforests and savannas are intermingled sympatrically in the Ugalla area. We found more 14 species from the savanna than from the tropical rainforest. This might be explained by the location and vegetation of Ugalla. Ugalla is located in the miombo forest in the intermediate zone between the moist rainforests and dry acacia savanna (Itani, 1993: 63–93; Kano, 1971; Moore, 1994). Ugalla contains one of the most arid open woodlands, and the evergreen forest covers only 9.8% of the gross area of the Ugalla Basin (Idani, 2002; Ogawa et al., 1999; 2007). This may result in fewer mammals from tropical rainforests inhabiting this area.

II. Habitat Condition in Ugalla

The ecology of some mammals in Ugalla was different from that in other regions of Africa. The diet of African civets in eastern and western Africa is composed of wild fruits, carrion, rodents, insects, myriapods, snails, crabs and the eggs of ground-nesting birds (Kingdon, 1977: 162; Ray, 1995). Thus, civets have a varied diet, but there was no mention of honey. In Ugalla, in contrast, African civets eat honey. Villagers visit this area frequently to collect honey in the miombo forest, and they stay in camps for several days. Civets might come to scavenge food from these camps and eat honey leftovers. As a result, they remember the taste of honey, and they may begin climbing trees to find honey themselves.

Hybrids of different genet species have been observed in the wild only rarely (Gaubert, personal communication). However, we observed many possible hybrids of the miombo genet and central African large-spotted genet. Hybridization between these two genets may occur frequently in the miombo forest.

In general, leopards minimize kleptoparasitism by caching prey (Balme et al., 2007; Estes, 1992: 366–369; Sunquist & Sunquist, 2002: 318–342). Leopards hoist 84% of the total prey in Kruger National Park and 76% of the total prey in Londoloizi Game Reserve, South Africa, into trees (Balme et al., 2007). In Phida, they store prey mainly in dense vegetation on the ground (Balme et al., 2007). In Ugalla, however, leopards cached prey in rock caves or buried it in the ground, and we never observed prey cached in trees or dense vegetation. In regions with small scavenger populations, leopards rarely hoist prey into trees (Smith, 1977; Bothma & Le Riche, 1984), and most prey are cached on the ground within dense vegetation in forested habitats (Karanth & Sunquist, 2000). The population density of lions and hyenas that plunder leopard prey may be relatively low in Ugalla, which may affect the caching behavior of the leopards. This hypothesis is supported by the fact that the leopards in Ugalla cached prey in rock caves so that raptors and arboreal carnivores would not steal their game. We found evidence that some animals ate an African land snail. According to local guides, leopards eat giant African land snails when a food shortage occurs (Tano, Hamisi, Nuhu, John, personal communication). The land snails that we found in this study may also have been killed by leopards. It is expected that African land snails provide nutrients to leopards when other prey are scarce.

Leopards hide their juveniles in trees in Serengeti National Park (Schaller, 1972: 23–33). Footprints indicated that a mother leopard left her juvenile in a rock cave in Ugalla. Leopards may have unique infant-rearing behavior patterns in the miombo forest.

Blue monkeys and red-tailed monkeys were previously observed only in the evergreen forests in Ugalla, but we observed them in woodlands. Commercial wood felling has been actively conducted in this area for more than 20 years. The principal trees used for lumber, *Pterocarpus angolensis* and *P. tinctorius*, were nearly extirpated (Ogawa et al., 1999). Recently, these and other trees have been cut down for lumber. As a result, the numbers of feeding trees for blue monkeys and red-tailed monkeys are decreasing. Artificial changes to the ecosystem may affect the feeding ecology and habitat use of these primates. It is possible that these changes have expanded and diversified the home ranges of primates.

Wild chimpanzees normally stay in their nests throughout the night and seldom move in the darkness (Riss & Goodall, 1976). In fact, chimpanzees vocalize and go to feeding sites at night (van Lawick-Goodall, 1968; Izawa & Itani, 1966; Koichiro Zamma, unpublished data). However, there is no detailed description of their night-time behaviors. We observed that chimpanzees are active on the ground and in trees at night. They were active during a night with a full moon and light rain. Thus their night-time behaviors may be related to the moonlight and the weather.

The distribution of olive baboons was extended to the south of the Maragarasi River by the construction of a bridge (Ogawa et al., 2007). Olive and yellow

baboons live in troops consisting of 2–200 animals, and most male baboons emigrate to neighboring groups (Smuts, 1985). In Ugalla, therefore, male olive baboons might immigrate into a yellow baboon troop, creating hybrids. As olive baboons are larger than yellow baboons (Kingdon, 2004: 34–35), the olive baboon males are likely to be dominant over the yellow baboons during a fight and can take over the troops of the yellow baboons.

The olive baboon is a typical species of the acacia savanna, and the yellow baboon is a typical species of the miombo forest (Itani, 2001). Because of a border transgression from the original habitat of the olive baboons, however, the distribution changed and hybridization between the two species has occurred in this area.

Southern reedbucks sometimes form a herd during the dry season (Estes, 1992: 91–98; Skinner & Chimimba, 2005). They usually move in small groups of 2–3 individuals and never form a large herd, unlike cobs and waterbucks (Skinner & Chimimba, 2005: 675–678). In Ugalla, however, they moved in a herd consisting of 5–12 individuals. We observed these herds only during the rainy season. This suggests that the reedbuck herds change composition and social structure according to ecological conditions.

The bush hyrax shared burrows with other species, especially small mammals, in the Ugalla area. Mixed-species associations have been observed in many vertebrate species, but few behavioral studies have investigated associations among species from different mammalian orders (Jane & James, 2007). Moreover, there are few studies of mixed-species burrow sharing. Thus, this study may well be the first record of burrow sharing by many species. In the savanna, bush hyraxes share the same living holes with the rock hyrax (*Procavia capensis*), which belongs to same order, Hyracoidea (Hoeck, 1975). However, there is no detailed report of burrow sharing with other species. Multiple species may use the same burrow because of increases in the population density of small mammals. Such increases might occur when the population density of large carnivores, such as leopards and lions, decreases. The types of fauna in the Ugalla area did not change between 1960 and 1999, but the population density of some of the mammals has likely decreased (Itani, 1979; Kano, 1971; Ogawa et al., 1999).

In the 1990s, researchers frequently encountered lions and leopards and observed many footprints and feces (Itani, 1984: 153–211; Idani, unpublished data). However, the numbers of lions and leopards seem to have diminished, based not only on infrequent direct observations but also on the low density of their footprints, feces, and roars. Moreover, while lions came very close to our camp in the 1990s (Itani, 1984), these large mammals are now rarely seen (Idani, unpublished data).

Although Ugalla is an uninhabited area, many people visit Ugalla to collect honey, poach, and collect timber. People intentionally set fires to clear underbrush (Idani, 1995). Bush fires spread rapidly because the woodland is extremely dry during the dry season. Small mammals are less able to escape from bush fires than large mammals, and they hide themselves in rocky refuges. This may partially explain why several small mammal species use the same burrows and why the density of small mammals in the limited rocky sites has increased. Species such as bush hyraxes that cannot dig burrows by themselves use rock caves.

However, species that can dig burrows, such as the mongoose, were also burrowing at rocky sites. The mongoose might dig holes under rock overhangs in order to avoid collapse of the burrow due to rain. Soil burrows under overhanging rock are more likely to be shared by several species because they are more comfortable than rock caves that are cold and have markedly uneven floors.

Our findings indicate that various mammals visited rocky sites. In the dry season, miombo leaves fall and Gramineae herbaceous grasses wither in woodlands. At rocky sites, however, some succulent plants do not wither, even during the dry season. Moreover, kabamba-jike forms a pure evergreen forest interspersed by patches around rocky sites (Idani, 2002; Ogawa et al., 1999). This suggests that rocky sites are the most important place for herbivores in the dry season in Ugalla. Both herbivores and carnivores were observed frequently at rocky sites. Therefore, rocky sites provide the herbivores with a food resource and the carnivores with a hunting site. Rocks also provide small- and medium-sized mammals with shelters and dens. For these reasons, rocky sites are among the most important habitats for mammals in the miombo forest of Ugalla.

Our results suggest that mammals in Ugalla have miombo-specific ecology. However, various human activities may exert a great influence on the ecology of mammals, e.g., hybridization between yellow and olive baboons, changes in feeding ecology and environmental utilization by primates, hybridization of genets, sharing of rocky sites by different small mammals, and decreases in large mammal populations.

At present, large-scale development throughout Tanzania, and dam construction and road expansion around Ugalla, are in progress. The impacts of such human activity will have an immeasurably negative influence upon the wildlife and natural environment of this area. We now have an opportunity to promote our understanding of this precious natural area. Phenomena that have not been recorded will be lost, and they may become fairy tales told only through legends and folklore as a legacy of the past.

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NOTES

(1) We recorded temperature daily at the Nguye site between Sep. 2 and Sep. 24, 2011, and between Oct. 28 and Nov. 26, 2011. During the dry season, the daily maximum temperature was 32.2 ± 2.2°C (N = 23) and the minimum was 22.2 ± 2.4°C (N = 23). During the rainy season, the daily maximum temperature was 27.1 ± 2.8°C (N = 28) and the minimum was 20.8 ± 2.7°C (N = 28).

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Appendix 1. Local names of mammals in the Ugalla area

Common name	Swahili name	Ha name	Common name	Swahili name	Ha name
CARNIVORA			**ARTIODACTYLA**		
African clawless otter	fisi maji	inzivyi (zivyi)	Impala	swala pala	impalapala (palapala)
Marsh mongoose	nguchiro maji	ibhikala (ikikala)	Lichtenstein's hartebeest	konzi	inkonji (ikonji)
Bushy-tailed mongoose	nguchiro kijivu	ibhikala (ikikala)	Roan antelope	korongo	inkolonko (kolongo)
Side-striped jackal	mbweha miraba	imbwebwe (bwebwe)	Waterbuck	kuro	indoi (ndoi)
Black-backed jackal	mbweha fedha	imbwebwe (bwebwe)	Klipspringer	mbuzi mawe	utukinda (tukinda)
African civet	fungo	ibhibhuli (ikibhuli)	Common warthog	ngiri	insatura (satura)
Miombo genet	–	ubhushimba (kashimba)	Blue duiker	ndimba	digidigi
Common genet	kanu mdogo madoa	ubhushimba (kashimba)	Bushpig	nguruwe mwitu	inglwe (glwe)
Central African large-spotted genet	kanu vichaka	ubhushimba (kashimba)	Southern reedbuck	tohe kusi	inpwege (pwege)
Common dwarf mongoose	kitafe	ibhikala (ikikala)	Common duiker	nsya	ingelege (gelege)
Slender mongoose	nguchiro mwembamba	ibhibhuli (ikibhuli)	African buffalo	nyati	inbogo (nbogo)
Serval	mondo	ibhisamagwe (ikisamagwe)	Common eland	pofu	inimba (nimba)
African wild dog	mbwa mwitu	amabhingila (mabhingila)	Bushbuck	pongo	inpongo (pongo)
Honey badger	nyegere	ubhuhelele (akahelele)	Sitatunga	nzohe	nbawala (imbawala)
Banded mongoose	nguchiro miraba	ibhikala (ikikala)	Greater kudu	tanfala mkubwa	intandala (tandala)
Lion	simba	intambwe (tambwe)	**HYRACOIDEA**		
Leopard	chui	induladula	Bush hyrax	pimbi madoa	bhupimbi (akapimbi)
Hyena	fisi	infyisi (fyisi)	**TUBULIDENTATA**		
Fox	kahelele	imbwebwe (bwebwe)	Aardvark	mhanga	inyaga
PRIMATES			**CHIROPTERA**		
Red-tailed monkey	–	ivyondi (chondi)	Bat	–	bhinyalema (nyalema)
Blue monkey	kima	ikende (ikende)	**LAGOMORPHA**		
Northern lesser galago	komba senegali	ubhuhelele (akahelele)	African savanna hare	sungura	ubhukwavu (akakwavu)
Thick-tailed greater galago	komba masikio mukubwa	ubhuhelele (akahelele)	Smith's red rock hare	–	ubhukwavu (akakwavu)
Chimpanzee	sokwe mtu	ibhimanfu (imanfu)	**RODENTIA**		
Olive baboon	nyani	ibhikobhe (inkobhe)	Northern giant pouched rat	panya buku	bhimupata (kimupata)
Yellow baboon	nyani njano	ibhikobhe (inkobhe)	Cape porcupine	nungunungu kusi	ibhinyogoto (kinyogoto)
			Crested porcupine	nungunungu kishugi	ibhinyogoto (kinyogoto)
			Smith's bush squirrel	kindi vichaka	ubhuselemete (akaselemete)

*Swahili name (Mdee & Kiango, 2008): –, unclear.
*Ha name: plural field names and singular names are shown in parentheses.